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STATISTICAL SEAGER EQUATION FOR EXOPLANET AND SETI SEARCHES

Abstract

In 2013, MIT astrophysicist Sara Seager introduced what is now called the Seager Equation: it expresses the number N of exoplanets with detectable signs of life as the product of six factors: Ns=the number of stars observed, FQ=the fraction of stars that are quiet, FHZ=the fraction of stars with rocky planets in the Habitable Zone, FO=the fraction of those planets that can be observed, FL=the fraction that have life, FS=the fraction on which life produces a detectable signature gas. This we call the "classical Seager equation".

Now suppose that each input of that equation is a positive random variable, rather than a sheer positive number. As such, each input random variable has a positive mean value and a positive variance that we assume to be numerically known by scientists. This we call the "Statistical Seager Equation". Taking the logs of both sides of the Statistical Seager Equation, the latter is converted into an equation of the type log(N)=SUM of independent random variables.

Let us now consider the possibility that, in the future, the number of physical inputs considered by Seager when she proposed her equation will actually increase, since scientists will know more and more details about the astrophysics of exoplanets. In the limit for an infinite number of inputs, i.e. an infinite number of independent input random variables, the Central Limit Theorem (CLT) of Statistics applies to the Statistical Seager Equation. Thus, the probability density function (pdf) of the output random variable N will approach a Gaussian (normal) distribution in the limit, whatever the distribution of the input random variables might possibly be. But if log(N) approaches the normal distribution, then N approaches the lognormal distribution, whose mean value is the sum of the input mean values and whose variance if the sum of the input variances.

This is just what this author realized back in 2008 when he transformed the Classical Drake Equation into the Statistical Drake Equation (refs. [1] and [2]). In this paper we study the lognormal properties of the Statistical Seager Equation relating them to the present and future knowledge for exoplanets searches from both the ground and space.

REFERENCES

[1] Maccone, C. (2010),"The Statistical Drake Equation", Acta Astronautica, Vol. 67 (2010), pages 1366-1383.

[2] Maccone, C. (2012), "Mathematical SETI", a 724-pages book published by Praxis-Springer in the fall of 2012. ISBN, ISBN-10: 3642274366 — ISBN-13: 978-3642274367 — Edition: 2012.